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THE BANG METHOD

FOR THE

Repression of Tuberculosis in Cattle

BY

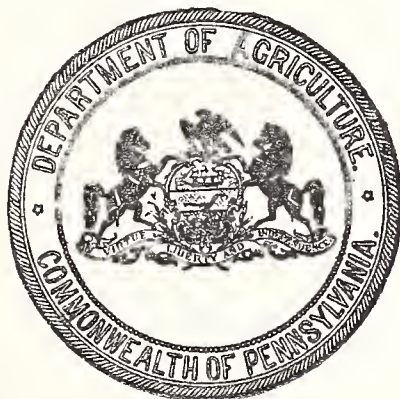
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With an introduction by

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DEPARTMENT OF AGRICULTURE,
VETERINARY DIVISION,
Harrisburg, Pa., Oct. 21, 1908.

Hon. N. B. Critchfield,
Secretary of Agriculture,
Harrisburg, Pa.,

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Sir: I have the honor to transmit herewith a paper with relation to the measures that have been adopted in Denmark against tuberculosis of animals. The paper is by Professor Bernhard Bang, of Copenhagen, whose name is well known to all interested in animal tuberculosis as the originator of the "Bang Method" for the repression of tuberculosis of cattle. This paper is adapted by Professor Bang to apply to our local conditions, and is published in its present form with his express authority.

I recommend the publication of this paper as a bulletin from the Department of Agriculture.

Yours respectfully,
(Signed) LEONARD PEARSON,
State Veterinarian.

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INTRODUCTION.

The Bang Method for the repression and eradication of tuberculosis of cattle was originated by Professor Bernhard Bang, of Copenhagen, in 1892. This method was placed in operation in Denmark in 1892, with the aid of a public grant, and has continued in use in that and in many other countries until the present time.

Although the Bang Method has repeatedly been described, it is still not so well understood, by cattle owners, as is desirable. Professor Bang has recently come to America to attend the Sixth International Congress on Tuberculosis and he has very kindly consented to permit the Department of Agriculture of Pennsylvania to publish, in bulletin form, a paper he has prepared on measures against animal tuberculosis in Denmark. In this paper he describes his methods and results. The paper should be read carefully by all who are concerned with animal husbandry; the information it furnishes is from the highest source, and it is prepared by one whose interests and sympathy are joined by the closest ties with the farmers of his native country.

The Bang Method for controlling tuberculosis of cattle is, above all, conservative; it enables the conservation and the utilization of all of the *value* cattle infected with tuberculosis may have. He encourages the use of such animals so long as they are profitable. Under the Bang system, there is no loss or waste through repressive measures; such loss as occurs is caused by the disease itself and not by the destruction of animals that are still serviceable, in efforts to eradicate the disease.

The Bang method as advised by the originator is, in brief, as follows:*

1. The herd is subjected to a careful physical examination.
2. All cattle with tuberculosis of the udder or with open tuberculosis should be killed.
3. The herd is tested with tuberculin by an officially designated veterinarian.
4. The cattle that react to tuberculin are separated from those that do not react.

*This outline has been read by Professor Bang and is printed as he approved it, October 20th, 1908.

5. The premises that are to be occupied by the non-reacting cattle are well disinfected.

6. The reacting and the non-reacting divisions of the herd are kept as far apart as is practicable. If possible, it is best to maintain them on separate farms or in separate buildings. In any case, they must be kept in quite separate apartments and be fed and watered separately. If they are cared for by the same attendants, the healthy cattle are to be attended to first and afterwards the tuberculous. Separate boots or overshoes and overalls should be kept for each stable. The two sets of cattle are to have separate pastures and watering places.

7. The milk (also the skim milk and butter milk) from the reacting herd shall be pasteurized before it is used as food for calves or swine. It is sufficient to heat to 176 degrees F. for one minute, or to 150 degrees F. for ten minutes.

8. The calves from the reacting cows should be removed from their mothers immediately or, at the latest, on the second day after birth, and thereafter fed milk from healthy cows or *the pasteurized milk* (heated as above) from reacting cows.

9. As cases of *open tuberculosis* develop among the cows of the reacting division, they are to be slaughtered.

10. The healthy division and the young cattle are to be tested with tuberculin, by an officially designated veterinarian, at periods of from six to twelve months. Cattle that react on such retests are to be isolated with the reacting division or they are to be slaughtered, according to their condition and value.

11. As modifications of the above plan, the following are proposed:

A. In case the original herd is highly tuberculous, instead of testing the mature cows, treat them as though all had reacted to tuberculin. That is, keep them apart from non-reacting cattle, separate their calves, and gradually rear from the old herd a new herd free from tuberculosis. The young cattle should be tested every six to twelve months, so that any that have accidentally become infected may be placed in isolation with the old herd.

B. In case it is not possible to feed calves pasteurized milk, or milk from non-reacting cows, the calves may be permitted to nurse from reacting cows that do not show signs of open or udder tuberculosis. But the calves must be left with the cows, and in the premises the cows occupy, as short a time as possible and only at feeding hours, two or three times a day. The cows must be confined in stalls so that they may not lick the calves and the cows and cow stable to which the calves have access must be kept unusually clean. The calves must be stabled in a separate stable or shed and shall be

tested by an officially designated veterinarian when they are six months old, before they enter the non-reacting herd.

By this method, as is explained in detail in Professor Bang's paper, it is possible to check further progress of tuberculosis among the cattle of an infected herd, and to grow a healthy herd from tuberculous ancestry.

The Bang method for dealing with bovine tuberculosis is especially recommended in relation to herds of pure-bred cattle and in other good breeding herds.

LEONARD PEARSON,
State Veterinarian.



THE BANG METHOD FOR THE REPRESSION OF TUBERCULOSIS IN CATTLE.

By BERNHARD BANG,

Professor at the Royal Veterinary and Agricultural College, Copenhagen, and
Chief Veterinarian to the Danish Government.

Measures against tuberculosis among domestic animals were first authorized by the State by act of April 14, 1893, relating to the prevention of infectious diseases among domestic animals.

According to Sec. 11 of this act cattle owners are prohibited:

(a) From sending animals (cattle and pigs), that *obviously suffer from tuberculosis*, to cattle sales and cattle shows, to common pastures, stables, etc., of other cattle owners as well as from selling such animals, except for slaughter.

(b) From selling or using as human food animals, or any part of an animal, *obviously suffering from tuberculosis*, unless a veterinary surgeon's certificate be produced stating that a previous examination of the carcass and the entrails, has shown the meat to be fit for human consumption.

(c) From selling the milk of cows, suffering from *tuberculosis of the udder* or using it as human food or in the preparation of food, or as food for animals, except when boiled.

These measures have, however, produced few practical results. It is true that a number of animals have been rejected when presented for admittance at cattle sales and common pastures or for exportation, and no doubt the sale of such animals for other than killing purposes has now and then been prevented; still, it is difficult to impose fines in such cases, the term "*obviously tuberculous*" being too vague. Paragraphs b and c were amended later, so as to provide more fully for the cases mentioned in them.

By the act of April 14, 1893, relating to *State help towards the combating of tuberculosis among cattle* an attempt was made to encourage cattle farmers to take measures to get rid of tuberculosis among their stock. By this act a sum of 50,000 Kr. yearly (after-

wards increased to 100,000 Kr.) was—for a term of five years—placed at the disposal of the Ministry of Agriculture to pay for gratis distribution of *tuberculin*, for the *injection of this substance by veterinary surgeons*, for measuring the temperature of the animals and for giving directions as to isolation, if the farmer in question wished to have the *tuberculin test* applied to ascertain which of his animals were infected with tuberculosis, but only *on condition of his binding himself to keep the healthy animals safely isolated from those suffering from tuberculosis*.

As the primary object of these measures was to promote the breeding of *healthy young cattle*, at first only young animals were tested gratis; soon, however, the test was also applied gratis in the case of full-grown animals, and gradually it became quite common to subject the whole stock of a farm to the tuberculin-test in order to make it possible to isolate the healthy among the full-grown animals.

The passing of this act was chiefly due to a proposal of the writer, who for some years past had been studying the efficacy of tuberculin for proving the existence of tuberculosis among cattle and other domestic animals, and who had worked out a system for the extermination of tuberculosis in an infected herd, by thorough *isolation* of the animals that were not yet attacked and by *preventing the transmission of infection through raw milk*.

According to the writer, *tuberculosis is a purely contagious disease*. It is true that infection may take place in the uterus, so that the calf is born tuberculous, but this happens very rarely, practically only when the cow is highly tuberculous. *Most calves are born healthy*, even if born of somewhat tuberculous cows, and they will remain so, if they are only preserved from infection. In the first place: *tubercle bacilli are not ubiquitous*. They are mostly found in stables, where tuberculous animals discharging tubercle bacilli are or have lately been stabled. Secondly: *raw milk very often transmits infection*, mostly it is true, when the udder of the cow is attacked, but also frequently when this is not the case, partly because tubercle bacilli *may* be excreted through an apparently healthy udder, if the cow is highly tuberculous, partly because pure milk may be fouled by the introduction of tubercle bacilli through flux of the uterus or by particles of the faeces of cows with open tuberculosis.

The tuberculin tests proved that a great number of cattle of all the herds *among which tuberculosis had long been prevalent* were infected with this disease. *Post-mortem examinations* proved, however, that *most of the re-acting animals were only slightly affected*; in many cases only small caseous-calcareous deposits were found in a few of the lymphatic glands, processes that no doubt often remain unchanged for years or are even sometimes cured.

According to the writer, therefore, there was no reason to kill milch-cows that did not show clinical signs of tuberculosis, but only reaction to tuberculin. So long as they were stabled in isolated stables, there was no reason why such cows should be killed or why their milk should not be used and their calves reared, provided the latter were as soon as possible removed from the infected stable and were not infected by being fed on the raw milk of tuberculous animals. The animals with advanced or open (clinical) tuberculosis should not, of course, be allowed to form part of the herd of reacting cows, but should be killed as soon as possible—a measure, which, to be sure, had often been taken in former times, though not nearly as often as circumstances demanded.

It will be seen that these measures—devised by the writer and founded on the above facts—for combating tuberculosis among cattle, interfered as little as possible with the use of the herd. I wanted farmers to remove from their herds only such animals as from reasons of general economy they would feel inclined to remove, i. e., the animals that a clinical examination proved to be tuberculous. They were allowed to keep those that did not appear tuberculous until subjected to the tuberculin test, as long as they found they yielded sufficient milk, and to rear their calves, if only they took good care to keep the reacting cattle isolated from the perfectly healthy animals. If the isolation could not be carried out in any safer way (which would, of course, be preferable), a part of the stable might be partitioned off by a wooden partition, reaching from the ceiling to the floor. The common water trough would have to be cut off, or if this was not practicable, it might be sufficient to let the water pass *first* through the part of the stable reserved for the healthy animals. If absolutely necessary, it would be permissible to have tight-fitting doors in the partition-wall though this has certainly often proved a drawback, it being, of course, very difficult to keep such doors shut when not in actual use. Whenever it is at all possible, as it would be in the case of a large herd, there ought to be two sets of stable hands, one for the healthy animals, one for the infected ones. If this was not possible, the servants would have to tend and milk the healthy animals *first* and have two sets of boots or shoes and overalls as well as of implements, one for each class of animal. In the pastures the two divisions would also have to be kept apart as much as possible, though the danger is considered to be less when the animals are grazing than when they are in the stable.

As from the very outset it was quite clear to me that isolation of the animals on the same farm, especially if such had to be effected in *one* building by means of a partition-wall, could not be a complete

guarantee against the introduction of contagious matter to the healthy animals, and that the tuberculin test was not in every case quite infallible (for instance, the animals might have been infected just before the test and so be unable to react), I directed that the healthy division was to be subjected to the tuberculin test once—or preferably twice—a year, so that those animals, which in spite of the isolation proved to be infected, might be removed without delay from the healthy division to the reacting one, the object being *the gradual purification of an infected herd during the course of several years*. It would thus become possible for a farmer possessing a herd in itself valuable, though infected with tuberculosis, to gradually convert it into a healthy one by breeding from his own stock.

As early as 1892, I was enabled by a special Government grant to demonstrate the practicability of my theories by gradually changing a highly tuberculous herd into a healthy one. The farm of *Thurby-lille* was selected for this experiment. On the first application of the test, 131 animals reacted, while only 77, mostly young animals, were found to be healthy. Of the milch-cows, 80 per cent. reacted, and of the young cattle and calves only 40 per cent. The isolation of the two classes, the reacting and the healthy ones, from each other was effected by partitioning off a part of the stable with a solid wooden partition, the shed occupied by the calves forming part of the healthy division. There were two sets of stable hands, one for each of the two divisions, and the two divisions or parts of the herd were, moreover, kept apart when grazing as well as in the stable.

The practicability of the plan was soon proved, as the calves which were born in the infected division of reacting parents were nearly all found to be healthy (very few being born tuberculous) and remained so, provided they were at once removed from the infected stable and fed on boiled milk, their mother's milk (raw) only being given to them on the first day.

Still, as had been expected, year by year, some of the animals of the healthy division did not pass the half-yearly test; in other words, some infection was introduced into the healthy division in spite of the isolation. Generally it was only one or a few per cent. that did not pass the test; on a few occasions, however, it was as much as nine per cent. It will thus be seen that the elimination of the infection proceeded rather slowly, but then circumstances were rather unfavorable, because the isolation was not a thorough one, the daily control was less effective than might have been desired, and lastly because the farmer was not sufficiently alive to the importance of removing highly tuberculous animals, discharging great quantities of bacilli, from the reacting division.

In spite of these drawbacks, the healthy division increased year by year and at last the task of eliminating the disease was successfully accomplished by selling the remainder of the reacting division, about 30 head of cattle. The farm is now one of those that supply Copenhagen with "Milk for Infants" (i. e., certified milk); the stock is every year subjected to the tuberculin test and the last time, in 1907, *not one* out of 211 animals reacted.

As the act of 1893 provided generous assistance to such cattle-farmers as were anxious to improve the sanitary condition of their herds by employing the method which had been tried at *Thurebylille*, a great number of both small and large farmers set to work, in many cases with excellent results. At all large farms, however, where tuberculosis is generally very prevalent, the elimination of infection progressed *slowly*, just as had been the case at *Thurebylille*; a few of the animals of the healthy division reacting whenever they were subjected to the test a second time. The stricter the isolation, the better the results; the best results being, of course, achieved, when it was possible to remove the healthy animals to another farm. The thorough *disinfection* of stables where highly tuberculous animals had been stabled, in order to destroy all contagious matter, often proved a very difficult task, especially in buildings where the wood-work and the stone floors were old and dilapidated. Where tuberculosis was not prevalent, as was very often the case among small herds and sometimes even among large ones (in one case, for instance, only 6 animals out of 134 reacted), it was, of course, easy enough to root out the infection completely.

By means of the numerous tuberculin tests which—especially during the first few years after the introduction of this method, which came to be known as Bang's Method—were applied to cattle in all parts of Denmark, *much valuable information was obtained as to the extent of tuberculosis in Denmark*, closely corresponding with the results obtained in all other countries where tuberculin was largely used. In many herds the disease was very prevalent. Among *large* herds (i. e., herds numbering 50 or more animals), only a few proved to be quite free from tuberculosis. Among herds of this size the average number of reacting animals was 50 or 60 per cent., while among *small* herds (numbering less than 50 animals), *a great number*, about one-fourth were perfectly healthy, and the number of reacting animals in infected small herds, was considerably less than that of the large ones, hardly 30 per cent.

The fact that a great many small herds consist of none but healthy animals (in 1898 there were 2,203 herds numbering 30,101 animals, on an average 14 in each), clearly shows that the opinion, prevalent among many medical men, that tubercle bacilli are *ubiquitous*, is

fallacious. They are never found except in places where animals (or human beings) discharging tubercle bacilli, live or have lately lived. *Tuberculosis is a purely contagious disease.*

This view is strikingly confirmed by a closer examination of herds among which tuberculosis is found. Only such herds are perfectly healthy as are kept up by *breeding*, receiving hardly any increase from outside, except a calf now and then, *while the prevalence of tuberculosis is generally the greater the more frequently the stock is increased by buying cattle at fairs*, and consequently the most infected parts of the country are those where a brisk trade in cattle is being done and where buying and selling of *cattle* is common.

Another way by which infection may be introduced among hitherto healthy herds is by feeding calves on *skimmed milk* from a co-operative creamery, amongst whose suppliers will always be found owners of tuberculous cattle. In cases where the infection had been introduced through the milk, the cows were very often healthy, while it was the calves or the young cattle that reacted; sometimes the peculiar fact might be observed that only animals of the same age, for instance, yearlings or two-year-olds reacted, and when this happened, the apparatus for heating the milk of the creamery was found to have been out of order just at the time when milk was supplied to the set of animals that had reacted.

In all other cases the tuberculin test proved conclusively *that tuberculosis is more prevalent among old than among young cattle*. A close examination of 40,624 head of cattle, which during the years 1898-1904 were subjected to the tuberculin test *for the first time*, showed that of calves under 6 months 12.1 per cent. reacted, of yearlings (from 6 to 18 months) 27.5 per cent., of two-year olds (from $1\frac{1}{2}$ to $2\frac{1}{2}$) 38.6 per cent., of full-grown animals (from $2\frac{1}{2}$ to 5) 44.9 per cent., and of animals over 5 years old 48 per cent.; figures which correspond with the results of tuberculin tests in other countries, as well as with the experiences of slaughter-houses and with the results of the study of human tuberculosis.

The "Bang Method," *for enabling cattle-farmers to combat tuberculosis* by having their herds tested with tuberculin, followed by strict *isolation* of the healthy animals and feeding calves on uninfected milk (milk of perfectly healthy animals or milk heated to 185 degrees F. (now only 176 degrees F.) had at first many enthusiastic followers, as will be seen by the following tables:

	Herds.		Number of Animals Tested.		Percentage of reacting animals
	Total number	Number of herds tested the first time	Total number	Of these, reacted	
April, 1893—June, 1894; June, 1894—October, 1895; October, 1895—May, 1896; May, 1896—June, 1897; June, 1897—May, 1898; May, 1898—Jan., 1899.	327 1,873 930 7,316	327 1,645 745 3,012 2,165	8,401 44,902 20,791 84,897 65,788	3,362 17,303 6,622 21,668 15,642	40.0 38.5 31.9 25.5 23.8
1899,	1,454	618	35,533	7,725	21.7
1900,	1,293	543	33,568	6,759	20.1
1901,	1,101	417	26,078	4,976	18.0
1902,	695	259	18,818	2,857	15.2
1903,	895	396	23,347	3,531	15.1
1904,	646	213	19,364	2,875	14.8
1905,	738	277	23,164	3,750	16.2
1906,	705	221	24,161	3,370	13.9
1907,	689	294	25,035	3,398	13.6
1907,	580	232	22,982	2,252	9.8

After a few years, however, there was a sad falling-off. The carrying out of the above measures demands great vigilance and perseverance on the part of farmers as well as on that of their servants—qualities not often met with. The importance of strict isolation was not at first fully realized by all, the watchfulness was often relaxed, the disinfection of the stables was not always as thorough as it should have been, the milk was not always sufficiently heated. Many farmers thought the method too *troublesome* in the long run. If accidents happened, so that too many animals of the healthy division reacted on the repetition of the test, the farmer would lose courage and listen to the many voices (especially those of butchers and cattle-dealers), eager to assure him that the tuberculin test was mere humbug. The serious misuse of *tubereulin* in employing it for the *immunization* of *cattle intended for export* to Germany for *killing purposes*—these animals, according to the peculiar German regulations, are to be subjected to the tuberculin test in passing quarantine at the German frontier—contributed greatly to the dissemination of wrong ideas among the public. The well-known and unfortunate circumstances that highly tuberculous and, consequently, infectious animals sometimes do not react at all or only very slightly, must also be taken into account. Veterinary surgeons sometimes neglected to subject non-reacting animals to a sufficiently careful clinical examination, so that it sometimes happened that a specially infectious animal was placed among the healthy ones.

However, although there was a great falling-off, many farmers have

persevered and most of them—both owners of large and of small herds—have obtained excellent results. For instance, on the first application of the test in 1894 at the farm of *Borupgaard* in Jutland, 139 out of the total number (82 per cent. of the full-grown animals) reacted and only 86 were found to be healthy. When the test was applied at the same farm in 1908, out of 245 animals only *one* calf reacted and so slightly that the reaction must be considered doubtful. This excellent result had been attained by *strict isolation* (division of the large stable by a wooden partition and separate stables for calves and young cattle). According to the careful calculations of the owner of the farm, the total expense of the isolation was about 1,000 Kr.

When the test was first applied in 1896 at Count Wedell's estate *Wedellsborg* (Funen) 166 of the animals reacted and only 74 were found to be healthy. Now there is a herd of 264 head of cattle, of which only 3 reacted in 1908. In this case the division of the stable had been effected by means of a brick wall. Although during the first few years a very small per cent. of the animals of the healthy division failed to pass the half-yearly tests, the result was now and then rather bad, as when on one occasion as many as 22 per cent. reacted, which discouraged the owner of the estate so much that he very nearly gave up the whole thing. Fortunately, however, he persevered, and eventually reaped the reward of his exertions.

A well-known cattle-breeder—Mr. *Ahlmann*, of Langholt and Striben (Jutland)—had in 1895, 271 reacting and 68 healthy animals. At present the reacting division has been reduced to 10, while of the remaining stock on his two farms only 6 out of 373 animals reacted at the last test. Mr. *E. Tutein*, of Edelgave (Sealand), had in 1895 115 reacting animals and 48 healthy ones; the last time the test was applied, only 2 out of 158 reacted.

As early as 1899 in the report submitted by me to the veterinary congress of *Baden-Baden* (Congress Report, vol. 1, p. 541) I expressed the opinion that the best way of rooting out tuberculosis in a large herd among which the *disease had long been prevalent*, would be to subject at first only calves and young cattle and none of the full-grown animals to the test, as experience had shown that among such a herd 80 per cent. or more of the full-grown animals would react. Consequently only very little would be gained by isolating the 10 or 20 per cent. of non-reacting cows, as a great number of these animals, having for a long time been exposed to infection, would turn out to be infected, even if they did not react. Not a few of such cows will be found to have in some of the lymphatic glands small tubercles of long standing, encysted, it is true, and consequently harmless for the moment but still in some cases liable to break out again. By not subjecting the full,

grown animals of their herd to the test, farmers would avoid the unpleasantness of learning (and of having to tell their friends!) that the greater part of their stock was infected, and the task of isolation would be the easier at first.

It is really beyond comprehension that every great cattle-farmer, who is the owner of a valuable herd and *knows* it to be infected, does not take the simple precaution of *isolating his calves* from the full-grown animals of his herd and feeding them on *uninfected* milk, i. e., milk that is sufficiently *heated* or milk from a few *perfectly healthy* (non-reacting and clinically examined) *cows*. In countries where the "artificial" feeding, which is common in Denmark, is unknown, a way out of the difficulty would be to make some perfectly healthy cows act as wet nurses and suckle the calves. Indeed, as has been proved by the Hungarian *Ujhelyi*, good results may be achieved, even if the mothers are allowed to nourish their own calves, provided the calves are kept in separate stables except when they are let in to their mother for feeding two or three times a day. This breaking away from the isolation rule involves, of course, some danger of infection; there is, however, a great difference between such a brief exposure to infection and constant cohabitation in the same stable day and night.

Of course, the isolated calves should be subjected to half-yearly tuberculin tests so that the infected ones may be removed as soon as possible, and *the healthy stock which is being formed by the above measures should, of course, be kept continually apart from the old infected stock*. The *Ostertag* method of keeping the healthy animals isolated only as long as they are young and later stabling them together with the full-grown cattle, cannot by any means be recommended, as the infected herd, even though its sanitary condition may be *improved* by removing the most infectious animals by means of a careful *clinical control*, will never be so completely rid of animals that may transmit infection, as to obviate further danger. *This cannot be attained by the clinical control alone*.

For great landed proprietors, owners of *several* farms, it will be an easy matter to get rid of tuberculosis by sending all the healthy animals of their stock to one of their farms and gradually—by means of the above method—eliminating the infection from the herds of their other farms. The following account of how matters were managed at the farm of Ourupgaard and three other farms at Falster, belonging to Mr. Fr. Tesdorpf, may serve as an instance to show how infection may be rooted out in this easy and cheap way. Here a beginning was made in 1893 by subjecting calves and young cattle of the stock of Ourupgaard, but no full-grown animals, to the tuberculin test, with the result that 31 reacted while 152 were found

to be healthy. The healthy animals were strictly isolated first at Ourupgaard, in separate stables, later at two of the other farms. During the succeeding years the testing of this healthy stock of young animals as also of the calves that were born, was continued. At first the result here, as at many other farms, was sometimes rather unsatisfactory, for instance, in 1896, when 23 animals out of 361 reacted, but in time as the isolation was carried out more and more carefully, better results were obtained, until last year, when at the four farms belonging to Mr. Tesdorpf, only 11 animals out of 876 reacted. At one of the farms there is still a herd of 114 reacting (or non-tested) animals.

Just as good results have been obtained by Count *Danneskjold-Samsø* at his three large farms in the island of Sams. Here, as early as in 1891, a beginning was made by testing the calves, of which relatively few reacted. The reacting animals were killed, and the healthy calves and young cattle were kept isolated for some time; only, however, until the beginning of the calving season—which was certainly a great mistake (one that could not be prevented, the test being a private one). They were then placed in the large, well appointed stable, together with the non-tested cows, which, though apparently healthy, infected the others, so that when at length, in 1898, I prevailed upon Count D.-S. to have the whole herd, which during six or seven years had been continually recruited with absolutely healthy young animals, subject to the test, 286 animals reacted, while only 29 were found to be healthy. From that time the healthy animals were kept isolated at two of the other farms. In 1901 there were at one of these farms 208 animals which all passed the test and at another 126, four of which reacted. In December, 1907, there were in the healthy division 593 animals, of which 2 reacted, though doubtfully, on being subjected to the test. In addition, there was still at one of the farms a reacting division of about 30 cows. So the great task of changing a large tuberculous herd into an all but healthy one, by breeding, had been accomplished in 10 years, an excellent result indeed.

Excellent results may also be obtained by isolation at *one* farm, as will be seen by the two following instances: In 1896, Farmer *Langemann* of *Faurholm* had 45 calves subjected to the test, 15 of which reacted. From that time until now, the calves bred at the farm have been tested and the healthy ones kept isolated, while the full-grown animals of the stock were not tested. That they were highly tuberculous was proved by the fact that 19 of the apparently healthiest cows reacted on their being subjected in 1900 to the test as an experiment. Gradually, a perfectly healthy herd has been bred, numbering—in April, 1908—197 animals, *none* of which reacted when tested.

At the large estate of *Voergaard* in Jutland (belonging to Mr. *Scavenius*) the same method of leaving the full-grown animals untested at first was adopted. In 1895, 94 yearlings and two-year-olds were tested, half of which reacted. The result of continued isolation of the calves and the young cattle and repeated tuberculin tests (of the calves twice yearly, of the older animals only once), is that there were, in 1907, healthy divisions numbering 443 animals, of which only 9 reacted upon the application of the test, and a reacting division of 41 animals. The manager of the cattle-farm was much struck by the gratifying fact that *the cows live much longer now than at the time when tuberculosis was prevalent among them*, a fact that is of course of the greatest importance as regards the profits of cattle-farming, and which is generally taken too little into account.

It is by no means only at the large farms that excellent results have been obtained by the method of isolation. It is indeed quite possible to carry it out at *the small farms* as well. The difficulty at these farms is, of course, to find two sets of stable hands to tend and milk the two divisions, but on the other hand there is the advantage that at a small farm nothing escapes notice and that the farmer can personally see to the execution of his orders. A small farmer, if he has only intelligence enough to grasp the main point, can, much more easily than a great landowner, take care that the transmission of infection is avoided. Generally it will not be necessary to have two sets of stable hands, if only the rule of tending and milking the healthy division *first* is strictly adhered to and if the stable men change their boots or shoes and—preferably—their overalls as well, on going from one division to another, and use different sets of implements in the two divisions.

It is a fact that the carrying out of the method of isolation has been attended with excellent results on many small farms. Where only few animals reacted, it was easy enough to get rid of the disease; but also in cases where almost the whole herd was infected, the *gradual* elimination was often successfully accomplished. It may here be mentioned that it repays one's trouble to work for small farmers, men who have felt their economic existence threatened by the prevalence of tuberculosis among their cattle. These men are deeply impressed with the importance of getting rid of the disease and so take more care in performing their daily duties to avoid the transmission of infection than do most others.

The result of a computation I made in 1905 was that at 66 small farms, on which the average number of cattle was 29 head, a gradual changing of what were for the most part highly tuberculous herds into healthy ones had been successfully accomplished by the method

of isolation. When this work was begun the total number of reacting animals on these 66 farms was 1,045, and of healthy ones 780; when it was finished there were 1,896 healthy animals and *none* reacting. On being asked, several of these farmers told me that the work had certainly caused a good deal of *trouble*, but that the *expense* was nothing to speak of. Thus one farmer had by spending a sum of less than 200 Kr. on the establishment of two small provisional stables in one of his farm buildings, succeeded in changing his highly tuberculous herd from which, during the previous few years, he had been obliged to sell 12 cows and heifers for a very low price because they were so badly diseased, into a perfectly healthy one, numbering 30 head of cattle—in 1907 there were 36—which have been several times subjected to the tuberculin test and have each time been found to be healthy. Other farmers have achieved similar excellent results at still smaller cost.

It will thus be seen that there is not the slightest doubt that both small and large cattle-farmers may gradually change a tuberculous herd into a healthy one, if they are determined to do it and if they have *quite grasped* the nature and the modes of infection of tuberculosis.

N. O. *Nielsen*, veterinary surgeon (Remkolde near Vordingborg, Sealand), has had the good idea to persuade a great number of the small cattle-farmers of his district to join an *association* with the object of "promoting the breeding and maintenance of healthy, non-tuberculous herds of cattle and pigs." Only such farmers are allowed to join as have had their stock subjected to the tuberculin test and, in case of its proving only *partially* healthy, have suitably isolated the healthy animals from the diseased ones. No increase of the herd by animals of other stock, except calves under one month, is allowed, unless they come from a healthy herd and have been found healthy on being injected with tuberculin. The object of the association is, besides setting a good example, to facilitate the purchase of healthy animals, as members who want to buy or sell may apply for advice to one of their number, who keeps a list of the farms where healthy animals are for sale. To some of the members is delegated the task of superintending the heating of milk at the creameries. Members pay a subscription of 2 Kr. yearly.

The association was started in December, 1905, and has prospered so much that it has now 125 members possessing stock amounting to 2,740 cows and young cattle. (According to a report, dated Jan. 1, 1908, 2,070 of the 2,442 animals of the association were healthy and only 14 of the members had reacting—isolated—animals, 372 in all.) Within three years the task of rooting out tuberculosis from 25 herds of cattle has been accomplished by means of killing or

selling the reacting animals. (On the first application of the test 85 herds—most of them very small, it is true—were found to be healthy.) More than half of the cattle of the four parishes—the scene of the labours of the association—belongs to members. There is no doubt that such associations may do much towards rousing an interest in small farmers in the great problem: How to breed healthy cattle and pigs. “Union is Strength” may be more truly said of Denmark, where so much is achieved by *co-operative farming*, than of any other country.

The growing interest in the rational application of the tuberculin test and the method of isolation has—in addition to the foundling of the above association—manifested itself lately in another way.

During the last seven or eight years several thousand head of *Jersey cattle* have been imported into Denmark direct from the island of *Jersey*. These cattle, as well as all other cattle that are imported for breeding purposes, must undergo a brief quarantine detention and are subjected to the tuberculin test (in accordance with the act of Feb. 5, 1904, relating to the Combating of Tuberculosis among Cattle and Pigs). This has further corroborated the truth of the already well-known fact—that tuberculosis is all but unknown among the Jersey cattle, an interesting circumstance which is accounted for by the fact that the Jersey stock has been kept pure for more than 100 years, the importing of cattle, except for immediate slaughter, being prohibited, probably to prevent the introduction of rinderpest. Of the Jersey cattle imported into Denmark, only very few animals reacted on being subjected to the test, and when these animals were killed, it was either quite impossible to demonstrate the presence of tuberculosis (accidental fever) or it was found to be present in a very slight degree only (perhaps caused through human infection). On being placed among infected Danish cattle, healthy Jersey cows will very soon become tuberculous; sometimes they have been known to give way to the disease even quicker than Danish cattle. The man who first imported Jersey cattle and who is the most eager advocate of the introduction of this excellent breed, which, owing to its wonderfully *rich* milk, is of special value to a butter-producing country, viz. Mr. J. Larsen (Gaardbogaard) was fortunately also a very eager advocate of the use of tuberculin and has always taken good care to keep his stock free from tuberculosis. Consequently it has been easy for him to induce the majority of the cattle farmers who import Jersey cattle to keep their newly imported animals free from the disease by means of isolation. There are at present about 5,000 head of Jersey cattle in Denmark—on small as well as on large farms—most of which are either quite free from tuberculosis or successful efforts are being made to make

them so. At many of these farms the stock is composed exclusively of Jersey cattle, at some the breed is mixed.

The foregoing is chiefly an account of what is being done in Denmark to combat tuberculosis among cattle by the cattle-farmers, assisted by the State, which pays the expenses attendant on the tuberculin tests on condition the farmers bind themselves to keep their healthy animals safely isolated from the infected ones. In conclusion follows an account of the two laws with the same object (*as passed by the Legislature*):

The amendment in 1898 of the Tuberculosis Act of 1893 provides that all cows found suffering from tuberculosis of the udder are to be killed and that a partial compensation is to be paid to the owner by the State; further that all skimmed milk and butter milk returned from dairies to be used as food for calves and pigs is previously to be heated to 185 degrees F. In 1904 an amendment was added providing that the compensation for a cow, killed on account of tuberculosis of the udder, is to be increased a little, so as to represent one-third of the market value of the carcass, calculated at the current average price for meat of inferior quality, if the meat is declared by a veterinary surgeon to be fit for human consumption (which happens very rarely), and five-sixths of the market value of the carcass if the meat is condemned. By an amendment of the provision relating to the heating of the milk it was provided that the milk is now to be heated to 176 degrees F. instead of to 185 degrees F. and that this provision is also to apply to cream, destined for the making of butter for exportation. The object of this latter provision, which has, of course, in itself nothing to do with the endeavours to combat the prevalence of tuberculosis among domestic animals in Denmark, is to keep Danish butter free from viable tubercle bacilli. It cannot be said to have revolutionized the dairy work to any great extent, as the heating of buttermilk has always been performed indirectly by heating the cream. Long before 1898 it was common enough to heat the cream very considerably in order to insure the perfect purity of the butter. There is no doubt that the usual heating of the cream and the adding of cultures of acidifying bacteria before the churning has contributed much to the practically invariably superior quality of Danish butter.

The object of the killing of cows suffering from tuberculosis of the udder is to get rid as soon as possible of these animals, through which, more than through any others, infection may be spread to calves, pigs and other domestic animals and also, undoubtedly, to human beings, especially children, if the milk is taken raw. The endeavours to combat tuberculosis of the udder have met with great sympathy among Danish farmers. About 2,500 samples of milk of cows, sus-

pected of suffering from this form of tuberculosis, are sent in yearly through veterinary surgeons to the laboratory of Dr. Bang, and the microscopic examination of these samples, either of the particles, produced by exudation or—in case of the milk being unchanged—of the sediment after centrifugation, showed tubercle bacilli to be present in about 30 per cent. of the cases. After the killing of the cow, parts of the diseased udder are subjected to examination in order to ascertain the correctness of the diagnosis, which in only about 1 per cent. of the cases has turned out to be at fault. About 700 cows are killed every year and the compensation paid for them generally amounts to 50,000 Kr. yearly.

The object of the killing of cows suffering from tuberculosis of the udder is of course best attained if the diagnosis is established when still at an *early stage*. The fact is therefore worth mentioning that of the 6,228 cows suffering from tuberculosis of the udder, destroyed in Denmark in the course of 10 years, 2,149, or 34.5 per cent., were still at a very early stage of the disease, as the secretion of the diseased gland still had the appearance of natural or almost natural milk. In many other cases also the rooting out of these infectious animals has had great hygienic importance, as cows suffering from tuberculosis of the udder may often go on living for months after their milk has changed, and even though, at this stage, the milk is not generally mixed with uninfected milk, it still contributes to spread infection in the stable by being milked on the floor.

The compulsory slaughter of these animals is therefore indubitably justified, but much more ought to be done. The best thing would be to order all cows, suffering from "open tuberculosis," i. e., all which discharge tubercle bacilli through any of the excretory channels, to be destroyed by the owner and partial compensation granted. Should the authorities hesitate for the present from acting upon this recommendation—partly because of the expense, partly because it may be rather difficult in some cases to decide whether a coughing cow is suffering from pulmonary tuberculosis, especially of an ulcerative, infectious form—there is at any rate *one* form of tuberculosis, which is extremely easy to diagnose, as the presence of the bacilli may be proved directly, viz. *tuberculosis of the uterus*. This disease, which seems to be even more frequent than tuberculosis of the udder, is most infectious; not only are enormous masses of tubercle bacilli every day spread in the stable through the discharge from the vagina, but a great number are no doubt mixed with the milk during the milking. It is six years since the veterinary authorities of Denmark recommended that the same action should be taken with regard to cows suffering from this disease as with cows suffering from

tuberculosis of the udder, but up to the present day their advice has been disregarded.

The most important of all the measures against tuberculosis among cattle and pigs which have been carried out in Denmark is the law relating to the *heating of skimmed milk and butter milk* to 176 degrees F. before it is returned from the creameries or butter factories. As in Denmark nearly all milk not sold directly for consumption is sent to co-operative creameries, it is clear that there is very great danger of a wide dissemination of tuberculosis, if *raw* skimmed milk and butter milk are returned to the suppliers to be used as food for calves and pigs. There will always be among the suppliers of a creamery one or more farmers who have a highly tuberculous herd, one or more cows of which yield in the course of the year great quantities of infected milk, and so, by employing this milk, after it has been skimmed, to feed other cattle of other herds, the infection is spread to hitherto healthy herds. As mentioned above, this was formerly done on a large scale, and there is no doubt that most stocks of cattle and pigs in Denmark would gradually be infected in this way, if measures had not been taken to prevent it. Of course the heating of the *whey* ought to have been enforced by law as well; this was proposed, but the proposal was not accepted, chiefly because the heating of the whey is rather troublesome. It is, however, to be hoped that this measure will be carried out some day, though, as whey is mostly used for feeding *pigs*, it is not so important as the other dairy products, as regards tuberculosis of cattle, and, besides, cheese-making is not nearly so considerable in Denmark as butter-making.

In Denmark, the observance of the law regulating the heating of skimmed milk is controlled by the police as well as by the margarine and butter inspectors, who procure samples at the dairies and send them to the laboratory of Prof. *Storeh*, where they are subjected to his *colour test*, which consists of pouring a few drops of *paraphenylenediamin* and peroxide of hydrogen into the milk. The milk turns blue, if it has not been heated to 176 degrees F. Offenders against the act are fined. On the whole, the regulations governing the heating of milk are fairly scrupulously carried out, though, of course, there are exceptions. The best plan would be for one or two of the suppliers of each dairy to apply the above easy and simple test every day. This is done in some places and has produced very good results.

Another useful provision of the Tuberculosis Act is that the sediment, deposited on the sides of the cream-separator, is to be burned, which is no doubt always done now. In old days this product was now and then used as food for pigs, and thus many pigs were infected, as it contains enormous masses of tubercle bacilli which are separated from the milk by the centrifugal force.

ACT OF FEBRUARY 5, 1904, CONTAINING MEASURES
AGAINST TUBERCULOSIS AMONG CATTLE AND PIGS.

A sum of 100,000 Kr. granted every year by the Rigsdag (Parliament) on the recommendation of the Committee of Ways and Means—shall be placed at the disposal of the Minister of Agriculture for the support of cattle farmers, who wish to employ tuberculin as a diagnostic agent in combating tuberculosis among their cattle, the tuberculin test being applied according to detailed regulations issued by the Minister. The support shall be granted to none but such farmers as guarantee their ability to keep the animals, proved by the test to be healthy, safely isolated from the animals affected by tuberculosis, or which have not been subjected to the tuberculin test.

The Minister of Agriculture shall—on the same conditions—be entitled to employ part of the sum to support cattle-breeding associations which wish to subject the animals selected for breeding purposes to the tuberculin test as well as to support farmers' associations desiring to subject cows belonging to cottagers to the tuberculin test.

Farmers who do not fulfil their obligations with regard to isolation shall return to the State the grants which have been made to them in accordance with the above provisions.

Any veterinary surgeon superintending the application of the tuberculin test on a farm shall satisfy himself under penalty of a fine that safe isolation between the animals is established and if his orders to this effect are not obeyed by the farmer, he shall notify this to the chief veterinary surgeon of the country.

Applications from cattle-farmers, cattle-breeding associations and farmer's associations desiring to take advantage of the opportunity offered to them by this act of having their cattle subjected to the tuberculin test, shall be sent direct to the Minister of Agriculture.

Sec. 2.

Importation of live cattle from abroad shall only take place at such places as are mentioned in the regulations issued by the Minister of Agriculture. Immediately after their arrival the animals shall be quarantined and shall, in accordance with the regulations of the veterinary police, be subjected to the tuberculin test, according to regulations issued by the Minister of Agriculture, within five days after their arrival at the quarantine stable. After the test the non-reacting animals shall be left at the disposal of the owner while

the reacting animals shall either be returned or taken direct to a public slaughter-house or to a slaughter-house recognized by the Minister of Agriculture, where the same shall be destroyed under control of the veterinary police.

The expenses incurred in providing the requisite quarantine stables at the places of import as well as the expenses of the tuberculin tests—but none of the expenses attendant on the other measures mentioned in this section—shall be borne by the State.

The regulations relating to tuberculin tests, mentioned in Sec. 1, shall also apply to such other diagnostic remedies as may be recommended by veterinary authorities for the combating of tuberculosis among cattle and are approved by the Minister of Agriculture.

Sec. 3.

Animals imported for killing purposes may be exempted from quarantining and the tuberculin tests ordered in Sec. 2.

Such animals shall—after having been branded (see Sec. 4)—be taken direct to a public slaughter-house or to a slaughter-house recognized by the Minister of Agriculture.

The Minister of Agriculture shall be entitled to permit cattle imported for killing purposes—after having been marked—being taken direct to a cattle-market, where the animals shall be stabled so as to be—in the opinion of the veterinary police—duly isolated from all other cattle. From this place they shall be taken direct to a public slaughter-house or to a slaughter-house recognized by the Minister of Agriculture.

The animal imported for killing purposes mentioned in this section shall be killed within 10 days after their arrival in this country.

Sec. 4.

The Minister of Agriculture shall issue regulations for the marking of the imported animals.

Sec. 5.

Cows suffering from *tuberculosis of the udder* shall be killed in accordance with the regulations of the State under control of the veterinary police or in a public slaughter-house. The owner shall be entitled to a compensation for the animal, amounting to one-third of the market value of the carcass, calculated at the current price, according to regulations issued by the Minister of Agriculture. The owner shall further be entitled to a compensation for such parts of the animal as are declared by the veterinary surgeon to be unfit for human consumption, amounting to half of the value of the condemned

meat, calculated as above. Such parts of the animal as are declared fit for human consumption shall be left at the disposal of the owner.

The compensation as well as the expenses attendant on the killing shall be paid by the State.

Sec. 6.

None but such milk and butter milk as has been heated to a temperature of at least 64 degree Reaumur (176 degrees F.) shall be returned from creameries to serve as food for cattle and pigs. Exceptions from this rule may take place when the heating cannot be performed on account of an accident, which fact shall be made known to the person to whom the milk is to be returned.

The heating mentioned in this section shall also apply to all cream destined for the making of butter for exportation.

The sediment scraped off the sides of the cream-separator during the cleaning of the same shall be burned.

Sec. 7.

None but such milk and butter as has been sufficiently proved in the opinion of the Minister of Agriculture to have been heated to a temperature of at least 64 degrees Reaumur (176 degrees F.) shall be imported from abroad. The Minister of Agriculture shall, however, be entitled to grant exemption from the above prohibition when special circumstances necessitate it.

Sec. 8.

The carrying out of the provisions of this act shall be enforced by the veterinary police, the custom house officers and the butter and margarine inspectors in accordance with the directions of the Minister of Agriculture.

Sec. 9.

Offenders against the provisions of sections 1, 2, 3, 6 and 7 shall be liable to fines of from 10 to 20 Kr. for the first offense, in case of repetition to fines of from 20 to 200 Kr. Repeated offenses against Sec. 6 shall not be looked upon as such if at least one year has elapsed since the offender was last fined. The fines shall accrue to the exchequer. The proceedings in these cases shall be summary. In the case mentioned in Sec. 7 the prohibited articles shall be confiscated and heated to the temperature defined in the above section. In Copenhagen the proceeds of the sale of such articles shall accrue to the municipal fund, in other places to the poor fund.

Sec. 10.

This act, which shall not apply to the Faroe Islands, shall come into force October 1, 1904.